

# The Information System of the State Map Series in the Czech Republic

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**Abstract.** Land Survey Office (LSO) provides (inter alia) administration of the State map series of the Czech Republic. In recent years LSO has been developed in cooperation with a private company T-MAPY Ltd. an Information System of the State Map Series (Informační system státního mapového díla, IS SMD). IS SMD is based on GIS technologies of Esri with a cartographic extension made by the company T-Kartor. Spatial data are stored in an Oracle database in the data model of the Esri Geodatabase. The production line of IS SMD is managed by the application Workflow Manager developed by T-MAPY Ltd. The file oriented system has been replaced by the seamless databases. Data are edited by multiuser editing in the ArcGIS for Desktop environment. Change proceedings run in on-line mode of long optimistic transactions in a versioned geodatabase. The duplicity of cartographic data is minimized by using the cartographic representations in the model of the Esri Geodatabase. The support of data updating on the strength of changes detection in the source databases is the fundamental benefit. It makes possible to keep the information in databases up-to-date and to generate high quality cartographic outputs within large map series using the CPS eXpress cartographic extension. Thanks to the managing system Workflow Manager is possible to make efficient planning, monitoring and evaluating of the whole production process, which more than 60 workers participated on. The whole system is well designed and allow to significantly increase the production capacity of Basic and Thematic maps in scales 1:10 000 - 1:100 000 on the territory of the Czech Republic.

**Keywords:** State map of the Czech Republic, Base map, Database Cartography

## **1. Introduction**

The State Map Series of the Czech Republic has been published from the beginning of the seventieth years of the last century and subsequently the whole area of former Czechoslovakia was covered. The creation of digital topographic maps derived from newly created Fundamental Base of Geographic Data of the Czech Republic (ZABAGED®) started in 2001 and the whole area of the Czech Republic was covered by the newly elaborated digital topographic maps at scales from 1:10 000 to 1:1 000 000. During the creation of the new maps their updating also continuously started.

The former technology of map production was developed in MicroStation environment with the usage of the MGE extensions. The production line for producing Basic Maps of the Czech Republic, which was very modern at that time, became out-of-date over the last ten years; therefore it was decided to build the new technology of map production based on Esri environment.

There were high demands put on the new system from the very beginning. The most significant, but not all by far, were these:

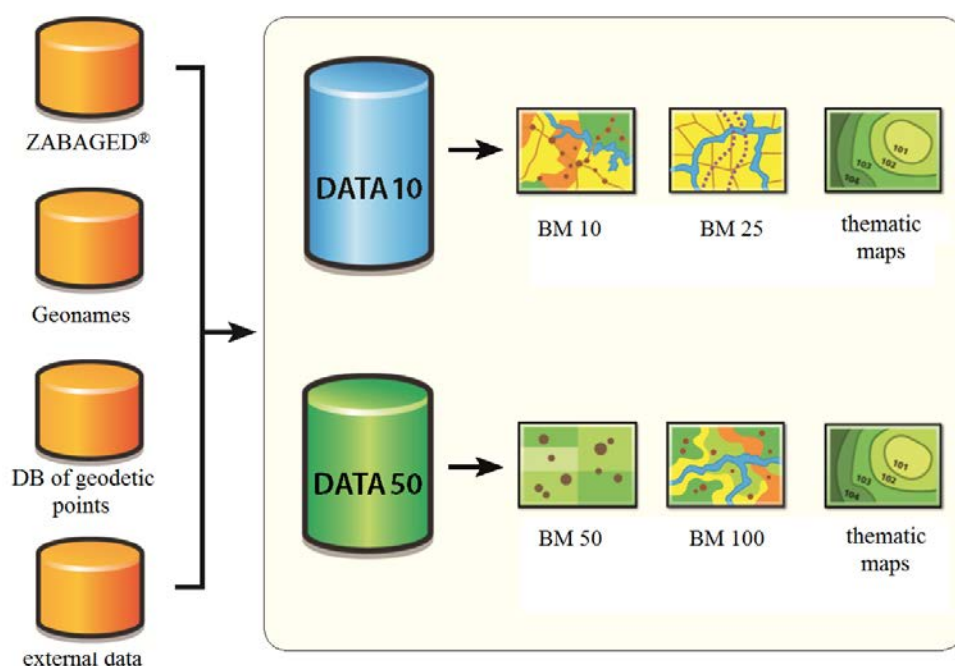
- keep linkage to the source databases – ZABAGED® and the database of geographic names (Geonames),
- to store data in a seamless database (this is one of the main difference between the new technology and the old one, where data were stored in separated files and each map sheet came as a project containing a lot of these files),
- for Basic Maps at scales 1:10 000 and 1:25 000 create cartographic visualization with the usage of cartographic representations (without geometry distortion of entry data),
- make the updating process by means of changes detection in the source databases (in comparison with the former concept, when a whole map sheet was remade),
- increase production of maps circa by 50% with preservation of the number of employees,
- keep high standard of printed outputs.

## **2. Technical solution**

### **2.1. The structure of IS SMD**

The data structure of IS SMD (figure No. 1) is divided into two more or less separated parts. One part called DATA10 is responsible for the production and the updating of ZM10 and ZM25 (Basic Maps at scales 1:10 000 and

1:25 000) and the other part called DATA50 is responsible for production and updating of ZM50 and ZM100 (Basic Maps at scales 1:50 000 and 1:100 000). It is also possible to make thematic alternations of the relevant scales within the scope of these two map groups. For all maps there are two main data sources – ZABAGED® a Geonames. Thematic databases (internal or from external providers) are used for making thematic maps.



**Figure 1.** The data structure of IS SMD.

## 2.2. The system architecture

IS SMD is designed as a three-layer architecture model, which provides optimal communication between data storage, an application layer and a presentation layer. When the system was being designed it was necessary to take into account that the client stations are situated in two cities. Some stations are in LSO headquarters in Prague and most of them are in 50 miles remote city Sedlčany, where are also servers. Communication between Prague and Sedlčany is provided by WAN with the transmission capacity 16 Mb/sec. The enter data are stored on a high-density disk array and their updating is provided by regular replications.

The server part of the solution consists of two separated servers. One server serves as a database server for DATA10 and the other one serves as a database server for DATA50 and also as an application server for all server applications of IS SMD. RDBMS Oracle 11g with an extension Oracle Spatial is used for data management. Communication with a database is provided via ArcGIS Server 9.3 Basic. There is also the server part of Workflow Manager for production control installed on the application server.

The client part consists of circa 50 workstations, 6 of them is connected via WAN. LSO uses 45 floating licenses of ArcGIS Desktop 9.3. IS SMD also uses ArcGIS extensions Data Interoperability for data import and export in various format, Maplex for support of correct text allocation, and 3D Analyst for hypsometry work. The part of the installation is also CPS eXpress for creating map templates.

### **3. Production system**

#### **3.1. The production of maps within the scope of DATA10**

The map sheets within the scope of DATA10 are produced at scales 1:10 000 and 1:25 000. IS SMD is likewise ready to process thematic maps according to customer's request. There are two outputs of the standard maps: in a form of a printed map of the uniform sheet line system or in a form of a digital raster map. The one of the main reasons for having a seamless database oriented production line was the possibility to offer map outputs (standard or according to customer's request) not corresponding with the uniform index sheet system.

All cartographic edits are proceeded in ArcMap environment. A work unit represents one map sheet of appropriate map series. A work unit includes all map elements within an envelope of change procedure, that is all elements within a map sheet with the outside buffer of 500 meters included and the elements of a map framework. Working on a map consists above all in solving collisions of single map symbols. An operator has to solve labels and plantation symbols which are close to a map framework in two ways: one is for displaying in a seamless map and the other one for displaying in the uniform index sheet system.

The processing of a cartographic image is proceeded in change procedures in a form of long optimistic transactions. This means all changes occur in the working version of a database (in the extent of a work unit) and not un-

til everything is done are they posted to the production version of the database.

Map sheets ZM25 are proceeded when the whole area of the map sheet is covered by approved map sheets ZM10. Cartographic representations created for ZM10 can be reused for ZM25, which significantly reduces time consumption. Of course, there can be in progress any number of map sheets.

A production manager chooses sequence of work units and thereby minimizes possible conflicts between the working versions of simultaneously running change procedures. The occurred conflicts are solved interactively with the system support (Reconcile). Not until are all conflicts solved the executed changes are posted to the production version of the database (Post).

Distinctively better user's environment is indisputable asset of the new technology. The previous technology worked with a wire model, which had its own symbol library, but to read incoming maps on monitor's screen needed experience and good imagination. In the new technology an operator edits in ArcMap in WYSIWYG interface (there are some features deliberately turned off e. g. masks by reason of speed of redrawing) and his orientation when working is considerably easier.

### **3.2. The updating of DATA10**

The process of updating comes from the request to be proceeded in a form of detection of changed data, not drawing a completely new map without connection to the last edition, such was in the old technology. There is no need to deal with features which weren't changed; therefore the progress of updating is much faster.

The process of updating map outputs is based on comparison of the original states and the new states of features entering IS SMD from the source databases. It is also possible to add another time profile without all changes from previous time profile being already made. A production manager puts together on the basis of their mutual geographical context and topological relations single change sentences to a larger unit and then he assigns it to an operator to handle it.

From comparison of two time profiles three categories of changed features originate. In the first category there are features of type "delete" – they were in a historical version and they are not present in a current version. The system automatically wipes out the cartographic representations of these features. In the second category there are features of type "insert", which were not in a historical version and are new for the system. The system automatically assigns a correct cartographic rule in this case. Both types of

features, "delete" and "insert, can be displayed by an operator and their relations to surroundings can be checked. In the third category are changed features of type "update", which are offered to an operator for adjustment of a cartographic representation and/or annotation.

### **3.3. The production of maps within the scope of DATA50**

Map sheets within the scope of DATA50 are produced at scales 1:50 000 and 1:100 000. As with DATA10 there are two outputs of standard maps - a printed map and a digital raster map. The principle of map elaboration is similar to DATA10, but entered data are handled differently. The DATA50 database was filled with the data of the existing MGE projects, so new maps are not created by direct derivation from the data of ZABAGED®. This technique was chosen because there are big changes in DATA50 caused by generalization, especially in layers containing build-up areas and follow-up generalization of these features would take unacceptable amount of time.

As with DATA10 all cartographic edits are proceeded in ArcMap environment and in change procedures in a form of long optimistic transactions.

The source for updating will be change data of the source databases. Single changes will be classified according to the three defined types, generalized and processed with the usage of editing tools. The features directly derived from the source databases will be automatically updated on the basis of change data of the source databases.

## **4. Outputs**

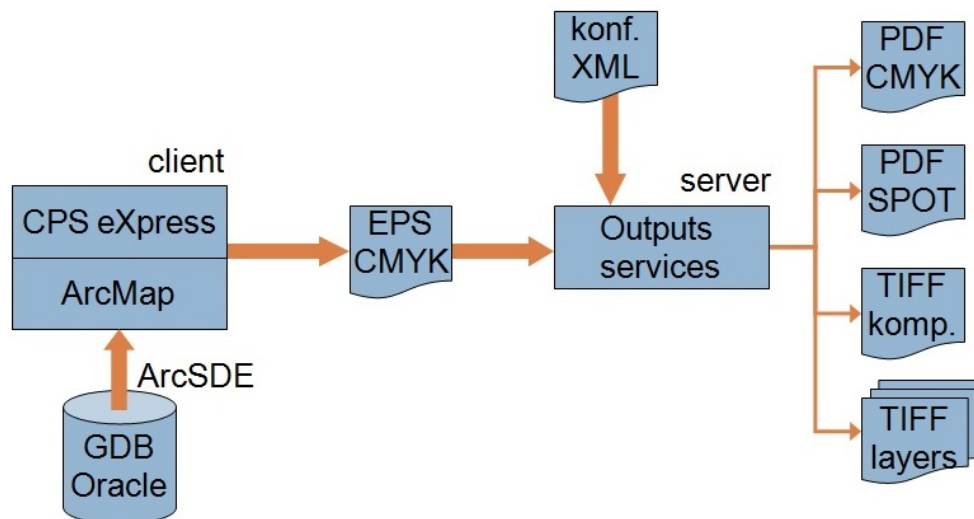
IS SMD currently produces the outputs for map printing (PDF of map sheets) and the outputs for providing data in digital form (raster outputs). The raster outputs are produced as georeferenced binary rasters (in separate layers matching a map sheet) and also as georeferenced composite raster files (seamless, 20 cm x 20 cm at scale of a particular map).

By the help of CPS eXpress, which is an ArcMap extension, EPS files are created and from these files the required formats are produced. CPS eXpress enables a cartographer to design a map product, which can be saved as a template in a database. A map edition is prepared for each map scale, thematic map and output format, in which is defined a map layout and templates for outputs (includes a coordinate grid and its description, map imprint, scale bar, legend, trim marks and other graphic features). Information about each map of a map edition are stored in an index layer, where each map sheet is described by attributes such as its area, name, nomenclature, scale, projection, adjacent map sheets etc. There is all needed information in a database to parametrically generate single maps, map sheets of

extensive map series or atlas pages automatically without manual interferences and modifications.

When an EPS file is created, the application server transforms this EPS file to the chosen output format such as PDF, TIF, CIT, JPG and so on (Figure No. 2). The services of the application server use a CMF metafile, where the colour conversion is defined, to control an input EPS file. The configuration file consists of:

- colour and attribute definition for conversion of EPS to PDF (tone, transparency mode, overprinting, opacity, colour model),
- colour definition for composite raster files,
- definition of separation for binary raster files distributed in layers



**Figure 2.** Outputs schema.

The CMF metafile contains the enumeration of colours defined in CMYK colourspace, which are allowed to occur in the input EPS file, and it also contains definition of required output colours. With using conversion services the colours in an EPS file are replaced with required output colours. Thanks to these services it is possible to use the different colour settings of PDF files for various printing machines. When an EPS file is placed in a particular folder, the service transforms the file to the required format (the kind of format – PDF, TIF, CIT, and JPG – depends on the folder). Where an EPS file is sent depends on our requirement (if we need printing file, binary raster files in separate layers or composite raster files).

The first of the main products of IS SMD are printing PDF (CMYK) in the map sheet division system, which are subsequently printed on a digital printing machine DICOPress (some thematic maps such as MORP are printed on a plotter). The source data is seamless, but for this kind of output with a frame and an outerframe information there is a special version with duplicate features needed for handling the situation on the boundary of the two adjacent map sheets. The printing PDF can be created also in direct colours.

The second output of IS SMD are georeferenced coloured composite raster files 20 cm x 20 cm at scale of a particular map in a coordinate grid S-JTSK in resolution 800 dpi. These raster files are generated as TIF files (+TFW). The resulting tessellation creates a seamless image of the whole area of the Czech Republic. The technology is prepared to concurrently generate JPG files (+JGW) if needed. It is also possible to change dpi resolution.

The last standardly created output are georeferenced binary rasters in separate layers in the map sheet division system of Base maps. It means that all features or elements of features to be precise, which have the same colour, are exported in one binary TIF file (+TFW). The created files is possible to put together to get the whole map again. There are for example 17 TIF files for Base map 10 at the moment, one for each particular colour. By the help of the configuration CMF file it is possible to merge discrete colours or to exclude them from the output. The production is set to produce TIF with 800 dpi resolution and CCITTFAX4 compression, but the technology is ready to produce CIT files as well or TIF files with different resolution.

Thanks to cooperation of ArcGIS, CPS eXpress and the services of the application server it is possible to control how the final map output will look. It is possible to configure the map content by switching off concrete layers (for example contour lines, water lines, railroads) and the output can be set together just from couple of required layers or even from particular symbols from various layers. It allows printing thematic maps with various compositions of symbols and labels. If we add the advantage of configuring colours in the configuration CMF metafile, we find that IS SMD does not have almost any limitations in term of the output map content and its visual.

The raster outputs of Base maps are getting more important nowadays. The rasters can be easily used as a background data for geographic information systems, as a basic part for thematic mapping or in form of map services for various map solutions. Thanks to the possibility to easily configure the appearance of an output it is relatively easy to prepare an output precisely corresponding with customer's requirements. On the present the rasters are, together with the direct sale, used as the colourful seamless Base map of the Czech Republic at the Geoportal ČÚZK ([geoportal.cuzk.cz](http://geoportal.cuzk.cz))



or at National geoportal INSPIRE (geoportal.gov.cz). Data is provided not only through WMS and WMTS services, but the data is accessible to users also in form of services of ArcGIS Server. Binary raster outputs are used for example in geographic information systems of administrators of distribution networks or everywhere else when a user does not need complete map content or if he wants to put it together from separate layers with his own chosen priority and colours.

Demands of users are still changing, therefore the outputs from IS SMD must be able to react on these trends. LSO plans for example adding hill shading to some printed maps. Thanks to further development of ArcGIS it becomes possible to create some outputs directly from ArcMap (base software of IS SMD) without need to use some extensions or other software. LSO also plans to use more PDF format and produce georeferenced multi-layer PDFs.

## 5. Conclusion

IS SMD uses via ArcGIS software and other extensions the most modern methods of digital cartography. The original file oriented system has been replaced by the seamless databases and this change offers more flexibility in creating various outputs and enables updating across a whole database. The system offers tools for effective administration of cartographic databases and automated map production for wide variety of defined products. The system brings higher production capability, which enables to speed up the map processing and to shorten the update cycle. The system also enables more flexible reaction on various demands from potential customers for making thematic maps. With regard to wide variety of usage for maps of medium scale as background maps in many geographic information systems, map portals and web applications LSO considers assumed improving seamless raster forms as one of the most important.

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